The Effect of Digitalization of Inventory System on Improving Material Management Efficiency in Research and Development Department PT XYZ Pharmaceutical Industry

Dara Prabandari Sumardi[1], Sahat Saragi[2], Nurmala Ahmar[3]

[1,2]Faculty of Pharmacy, Pancasila University, Jakarta, Indonesia
[3]Faculty of Economy, Pancasila University, Jakarta, Indonesia

Abstract

Pharmaceutical industry in Indonesia currently faces two challenges, which are the implementation of National Health Insurance and the trend of digitalization of e-Catalogs. Providing affordable medicines for the community at prices set by the government is a challenge for the pharmaceutical industry. Companies should produce drugs with the most efficient costs and processes. R&D Department in the pharmaceutical industry is a center for research and development of drug products. The challenge of pharmaceutical industry leads to the increment of R&D activity that is directly related to supply chain activities, especially in the Raw Material Warehouse. Digitalization of documentation process in the R&D Raw Material Warehouse is conducted to increase the efficiency of the material management process. The aim of this study was to evaluate the condition of Material Management process before and after digitalization, and to occur which variable has the most significant impact after digitalization. This research conducted using two methods: measuring process time of adjustment stock and tracing quantity material, and descriptive calculation of expired material cost and labor cost during reporting stock opname. From the results of the study, Positive Adjustment Stock process time decreased up to 25.6% and Negative Adjustment Stock process time decreased up to 30.2% after digitalization. However, Tracing Quantity Material process time increased 36.7% compared to before digitalization. Expired Material Cost decreased to 35.6% in 2024. The Stock Opname reporting process time decreased 96.4% after digitalization. So, it can be concluded that digitalization of inventory system in R&D Raw Material Warehouse had significantly impact for efficiency of Material Management process with Stock Opname reporting process is the variable that has the most significant impact after digitalization.

Keywords: Digitalization, Efficiency, Inventory System, Material Management, R&D department, Raw material warehouse

1. Introduction

The Pharmaceutical Industry is an institution engaged in the pharmaceutical sector to design, develop, and manufacture pharmaceutical products such as drugs, health supplements, and medical devices in accordance with established requirements. Based on BPOM data (1), there are 507 pharmaceutical industries in Indonesia that specifically producing drugs and supplements that already have a Good

Manufacturing Practice (CPOB) certificate. The pharmaceutical industry in Indonesia continues to grow every year. The growth of the pharmaceutical company sector shows an increase from year to year.

The pharmaceutical industry faces two major challenges, including the implementation of JKN (National Health Insurance) and e-Catalog. JKN is a government program to guarantee the national health system by prioritizing the availability of affordable drugs for all levels of society. The demands of the JKN program to provide affordable drugs for the community are a challenge for the pharmaceutical industry so that companies can produce drugs with the most efficient costs and production processes.

The second challenge for the pharmaceutical industry is the implementation of e-Catalog. e-Catalog is an electronic information system that contains a list, type, technical specifications, and prices of certain goods from various Government Goods/Service Providers (2). Since 2022, e-Catalog implemented the system of multi-winner, multi-price, and the assessment of TKDN (Domestic Component Level) of products displayed in the e-Catalog.

In the pharmaceutical industry, there are departments that are interrelated with each other, working to achieve the business goals of the company. One of them is the Research and Development (R&D) department. R&D in the pharmaceutical industry is the center of product research and development, from new products to me-too products so that these products can later be marketed commercially with applicable provisions.

There are several important aspects in the R&D Department to be studied for their implementation, including the R&D Raw Material Warehouse. The R&D Raw Material Warehouse is a place to store raw materials, both active substances and excipients materials used in the process of developing new products. The Raw Material Warehouse must be able to guarantee that the products produced from Research and Development activities can be guaranteed in terms of quality, so the products that has been produced can meet the specifications and market needs.

PT XYZ is a pharmaceutical industry that produces more than 200 products, consisting of generic products, OTC (Over-The-Counter), ethical, and supplements. The demands of the JKN program and the implementation of e-Catalog have greatly influenced the increment of development activities in Research and Development department to be able to create appropriate, affordable, efficacious, and safe medicines. The increase in R&D activities can be seen from the increasing number of projects, especially New Product Development in the R&D department every year. With the increase in R&D activities, directly, supply chain activities (including material management) especially in the Research and Development Raw Material Warehouse in the R&D department have also increased. Material Management activities in the R&D Raw Material Warehouse include receiving, storing, issuing, and managing expired raw materials.

Efforts to increase the efficiency of the material management process in the R&D Raw Material Warehouse are by digitizing the recording of raw material stocks. Digitalization is the process of changing the system to manage data from manual or analog to digital format using digital technology to collect, manage, process, store, and transmit data and information (3). Digitization in the material management process in the R&D Raw Material Warehouse is needed so that Warehouse management becomes faster and more efficient.

The problems faced in the material management process in the R&D Raw Material Warehouse are that material management activities are still carried out manually. The activities are recording the number of incoming goods, adjusting raw material stock when it has been issued or used, tracing the quantity of raw materials, detecting the expired date of raw materials, and reporting stock opname process. This study will examine the digitalization of the material management process in the R&D Raw Material Warehouse and its effects on increasing material management efficiency in the R&D department of PT XYZ.

2. Abbreviations and Acronyms

- R&D: Research and Development
- BPOM: "*Badan Pengawas Obat dan Makanan*" Indonesian Food and Drug Authority
- CPOB: "*Cara Pembuatan Obat yang Baik*" Good Manufacturing Practice
- JKN: "*Jaminan Kesehatan Nasional*" Indonesian National Health Insurance
- TKDN: "*Tingkat Komponen Dalam Negeri*" Domestic Component Level
- PT XYZ: Pharmaceutical Industry, refers to a place where this research is conducted

3. Methods

This research is a non-experimental study with quantitative data. The design used in this study is an analytical observational cross-sectional study with a prospective data collection method. The location of the research to be carried out is at the R&D Raw Material Warehouse of PT XYZ with the research time being carried out from May to November 2024.

There are 3 groups of raw materials used as objects of observation in this study:

- Solid active raw materials with a total of 107 raw materials
- Solid excipient raw materials with a total of 134 raw materials
- Liquid raw materials (active raw materials and excipient raw materials) with a total of 23 raw materials

The number of samples was determined using the Slovin Test and using the Stratified Random Sampling method. The samples used in this study were:

- Solid active raw materials with a sample size of 85 raw materials
- Solid excipient raw materials with a sample size of 100 raw materials
- Liquid raw materials with a sample size of 22 raw materials

The inclusion criteria in this study are solid active raw materials, excipient solid raw materials, and liquid raw materials (both active raw materials and excipient raw materials) that are still available and have not expired which are stored in the R&D Raw Material Warehouse. While the exclusion criteria are flammable liquid raw materials and capsule shells.

Data analysis was carried out using two approaches.

1. First Approach

Data obtained from measuring time on the variables Positive Adjustment Stock, Negative Adjustment Stock, and Tracing Quantity Material before the digitalization of the inventory system (when the material management process was still manual) and after the implementation of the digitalization of the inventory system were compared and the differences were analyzed. The data used is the time required to carry out a process, from the start of each process (initial) to completion (end).

The data that has been collected is then tested for Normality using the Kolmogorov-Smirnov Test. If the data is normally distributed, then to see the comparison before and after digitization, the data is then tested using the Pair-T-Test. If the data is not normally distributed, then the data is tested using the Wilcoxon Signed-Rank Test. The hypothesis is proven if the significance value of $t < \alpha$ ($\alpha = 5\%$).

2. Second Approach

Data on the amount of expired raw materials before the digitalization of the inventory system (when the material management process was still manual) and after the implementation of the digitalization of the inventory system are converted using the price of each raw material, so that the total cost of expired raw materials can be obtained, which is mentioned as Expired Material Cost.

Data from the Stock Opname reporting process time is converted with the salary of the Research and Development Raw Material Warehouse Staff to become Labor Cost. Data from Expired Material Cost and Labor Cost are then compared using a descriptive approach through the difference in the values of Expired Material Cost and Labor Cost before and after digitalization.

4. Results and Discussion

The intervention carried out in this study was by implementing digitalization of the inventory system in the material management process at the R&D Raw Material Warehouse of PT XYZ. The condition before digitalization was implemented the documentary of inventory system manually using Microsoft Excel. The intervention was carried out by digitizing the inventory system using Microsoft Dynamics NAV (Navision). Below are descriptive results of measuring process time for variable Positive Adjustment Stock, Negative Adjustment Stock, and Tracing Quantity Material.

Table 1. Descriptive Results of Positive Adjustment Stock Process

Group of Sample	Average Process Time Before Digitization	Average Process Time After Digitization
Solid active raw materials (n=85)	61,9 seconds	49,6 seconds
Solid excipient raw materials (n=100)	62,2 seconds	46,3 seconds
Liquid raw materials (n=22)	53,8 seconds	45,3 seconds

Table 2. Descriptive Results of Negative Adjustment Stock Process

Group of Sample	Average Process Time Before Digitization	Average Process Time After Digitization
Solid active raw materials (n=85)	46,0 seconds	32,1 seconds
Solid excipient raw materials (n=100)	40,8 seconds	34,7 seconds
Liquid raw materials (n=22)	39,7 seconds	32,2 seconds

Table 3. Descriptive Results of Tracing Quantity Material

Group of Sample	Average Process Time Before Digitization	Average Process Time After Digitization
Solid active raw materials (n=85)	13,5 seconds	16,1 seconds
Solid excipient raw materials (n=100)	13,0 seconds	14,8 seconds
Liquid raw materials (n=22)	9,8 seconds	13,4 seconds

Normality test was conducted using Kolmogorov-Smirnov method for solid active raw material group and solid excipient raw material group. Normality test also conducted using Shapiro-Wilk method for liquid raw material group. Normality test result for Positive Adjustment Stock, Negative Adjustment Stock, and Tracing Quantity Material variable can be seen as follows.

Table 4. Normality Test Results

Variable	Asymp. Sig. Value (α 0,05)	Solid active raw materials (n=85)	Solid excipient raw materials (n=100)	Liquid raw materials (n=22)
Positive Adjustment Stock	Before	0,2	< 0,001	0,135
		Normally distributed	Not normally distributed	Normally distributed
	After	< 0,001	< 0,001	< 0,001
		Not normally distributed		
Negative Adjustment Stock	Before	0,043	< 0,001	0,747
		Not normally distributed		Normally distributed
	After	< 0,001	< 0,001	0,002
		Not normally distributed		
Tracing Quantity Material	Before	< 0,001	< 0,001	0,106
		Not normally distributed		Normally distributed
	After	< 0,001	< 0,001	0,056
		Not normally distributed		Normally distributed

Note:

Hypothesis:

- H0: Data normally distributed
- H1: Data not normally distributed

Based of decision (α=0,05) (4):

- Probability / Asymp. Sig. Value > 0,05 → H0 accepted
- Probability / Asymp. Sig. Value < 0,05 → H0 rejected

Comparative hypothesis testing was conducted to see the differences in the processing time of each variable from the three groups of raw materials before and after digitalization. This difference test was conducted using SPSS software with the Wilcoxon Signed-Rank Test method with a significance level (α) of 5%. The results of the Wilcoxon Signed-Rank Test can be seen as follows.

Table 5. Comparative Hypothesis Testing

Variable	Wilcoxon Signed-Rank Test (α 0,05)	Solid active raw materials (n=85)	Solid excipient raw materials (n=100)	Liquid raw materials (n=22)
Positive Adjustment Stock	Asymp. Sig. (2-tailed)	< 0,001	< 0,001	< 0,001
	Ranks	Negative Ranks (n=67)	Negative Ranks (n=97)	Negative Ranks (n=20)

Variable	Wilcoxon Signed-Rank Test (α 0,05)	Solid active raw materials (n=85)	Solid excipient raw materials (n=100)	Liquid raw materials (n=22)
Negative Adjustment Stock	Asymp. Sig. (2-tailed)	< 0,001	< 0,001	< 0,001
	Ranks	Negative Ranks (n=78)	Negative Ranks (n=88)	Negative Ranks (n=21)
Tracing Quantity Material	Asymp. Sig. (2-tailed)	< 0,001	< 0,001	< 0,001*
	Ranks	Positive Ranks (n=63)	Positive Ranks (n=69)	NA

* The difference test was carried out using the Paired T-Test method because the data was normally distributed

Hypothesis:

- H0: There is no significant difference in the variable compared to before and after digitalization.
- H1: There is significant difference in the variable compared to before and after digitalization.

Based of decision (α=0,05) (4):

- Probability / Asymp. Sig. Value (2-tailed) > 0,05 → H0 accepted
- Probability / Asymp. Sig. Value (2-tailed) < 0,05 → H0 rejected

From the table above, it can be concluded that there is a significant difference in the Positive Adjustment Stock and Negative Adjustment Stock variables compared to before and after digitization for all sample groups. The time required for the Positive Adjustment Stock and Negative Adjustment Stock processes for all sample groups decreased after the intervention. So it can be concluded that the material management process is more efficient after digitalization.

Contrary with other variables, for the Tracing Quantity Material variable, the time required for this process for all sample groups actually increased after the intervention. This result can be caused by the many features in the Navision system where this feature can slightly slow down the Tracing Quantity Material process in the Navision system.

Detection of expired material is the process of tracking raw materials that are about to expire or already expired, either manually or through the system. This process was carried out manually through Microsoft Excel before the inventory system is digitized. The disadvantage of manual detection process is delay in early detection for raw materials that are almost expired, causing many raw materials to expire because the FEFO (First Expired First Out) process is not implemented optimally. With the digitalization of the inventory system in material management in the R&D Raw Material Warehouse, this detection can be done automatically.

The quantity of expired raw materials will be converted using the price of each raw material, so that the total cost of expired raw materials can be obtained, which will be mentioned as Expired Material Cost. The following is a tabulation of Expired Material Cost.

Table 6. Total Expired Material Cost in 2021 – 2024

Period	*Expired Material Cost*	Total *Expired Material Cost* in a year	Note
January-June 2021	Rp 18.017.520,00	Rp 24.997.938,00	Before Digitization
July-December 2021	Rp 6.980.418,00		
January-June 2022	Rp 59.450.360,00	Rp 72.020.487,00	
July-December 2022	Rp 12.570.127,00		
January-June 2023	Rp 7.315.827,00	Rp 116.110.819,00	
July-December 2023	Rp 108.794.993,00		
January-June 2024	Rp 42.715.218,00	Rp 74.831.512,00	
July-December 2024	Rp 32.116.295,00		After Digitiza-tion

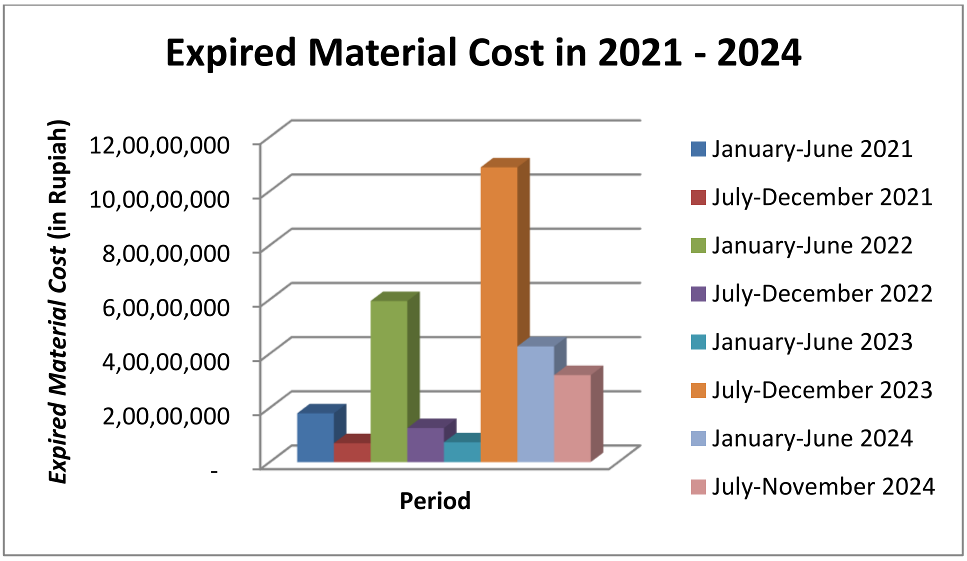

Figure 1. Expired Material Cost in 2021 – 2024

From this data, it can be concluded that digitalization has positive impact on the efficiency of material management in the R&D Raw Material Warehouse where Expired Material Cost can decrease IDR 41,279,307.00 or 35.6% in 2024.

Stock Opname Reporting Process is the process of summarizing raw material stock data stored in the raw material warehouse to become a report that is carried out periodically either manually (using Microsoft Excel) or through the system. Stock Opname reporting process time will be converted using the basic salary of warehouse staff per hour so that the Labor Cost of the Stock Opname reporting process for that period can be determined.

Table 7. Stock Opname Reporting Process Time and Labor Cost of Stock Opname Reporting Process 2021-2024

Parameter	2021	2022	2023	2024
Process time (hour)	10	15	28	1
Labor Cost	Rp 292.912,00	Rp 439.368,00	Rp 820.154,00	Rp 29.291,00

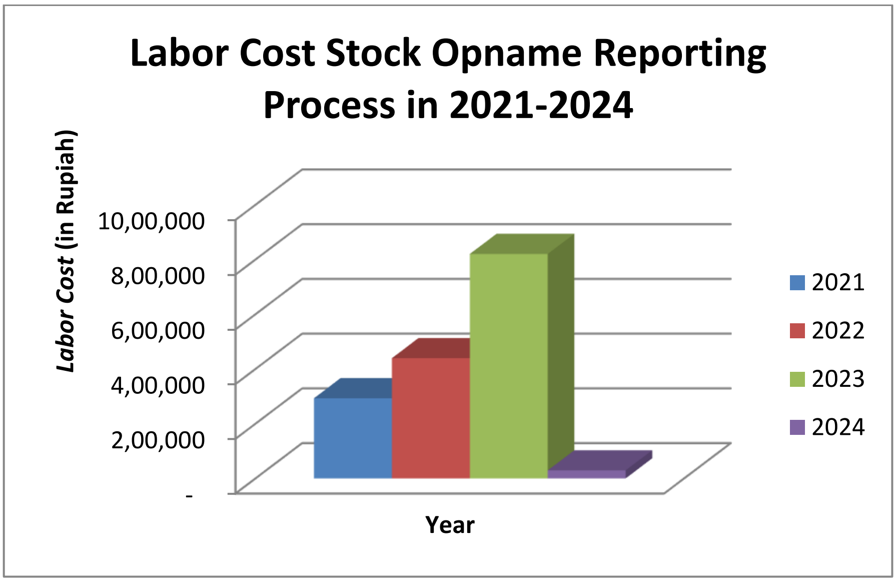

Figure 2. Labor Cost Stock Opname Reporting Process in 2021-2024

5. Conclusion

The results of the study on the Positive Adjustment Stock and Negative Adjustment Stock process time variables showed that there were significant differences between the process time before and after digitization for all sample groups. The results of the statistical analysis showed that the time required for the Positive Adjustment Stock process time decreased up to 25.6% and Negative Adjustment Stock process time decreased up to 30.2% after digitalization. So, it can be concluded that the digitalization of the inventory system has an impact on increasing the efficiency of the Positive Adjustment Stock and Negative Adjustment Stock processes.

Contrary to the previous 2 variables, the results of the study on the variable of the Tracing Quantity Material process time show that there is a significant difference between the process time before and after digitization for all sample groups where statistical analysis shows that the time required for the Tracing Quantity Material process increased 36.7% after the inventory system is digitized. So, it can be concluded that the digitalization of the inventory system does not affect the increase in the efficiency of the Tracing Quantity Material process.

The results of the study with descriptive analysis on the Expired Material Detection variable show that digitalization has a positive impact on the efficiency of material management in the Research and Development Raw Material Warehouse where the Expired Material Cost can decrease IDR 41,279,307.00 or 35.6% in 2024. So, it can be concluded that the digitalization of the inventory system has an impact on increasing the efficiency of the Expired Material detection process.

The results of the study with descriptive analysis on the Stock Opname Reporting Process Time variable show that digitalization has a positive impact on the efficiency of material management in the Research and Development Raw Material Warehouse where the Stock Opname reporting process time decreases to 1 hour in 2024. This decreased process time has an effect on decreasing Labor Costs, where the Labor Cost for the Stock

Opname reporting process in 2024 decreased by 96.4% from the Labor Cost in 2023. So it can be concluded that the digitalization of the inventory system has an effect on increasing the efficiency of the Stock Opname reporting process and this variable has the most significant impact after digitalization.

6. Acknowledgements

The author wishes to express their gratitude to the Research and Development Department of PT XYZ, for providing unwavering support throughout this research project.

7. References

1. Badan POM. Data Sertifikat CPOB [Internet]. 2023 [updated 15 July 2023; accessed 15 July 2023]. Accessed from https://e-sertifikasi.pom.go.id/dataSertifikat
2. Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah, Pengadaan Obat oleh Faskes Swasta melalui E-Katalog & E-Purchasing. Jakarta: Direktorat Pengembangan Sistem Katalog Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah; 2017, h 2.
3. Fahrurrozi M. Entrepreneurship dan Digitalisasi Mengembangkan Bisnis di Era 5.0. Indonesia: Universitas Hamzanwadi Press; 2023, h 7.
4. Santoso S. Statistik Nonparametrik: Konsep dan Aplikasi dengan SPSS. Jakarta: Elex Media Komputindo; 2010, h 89-90.
5. Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah, Pengadaan Obat oleh Faskes Swasta melalui E-Katalog & E-Purchasing. Jakarta: Direktorat Pengembangan Sistem Katalog Lembaga Kebijakan Pengadaan Barang/Jasa Pemerintah; 2017, h 2.
6. Kainulainen S. Research and Development (R&D). Encyclopedia of Quality of Life and Well-Being Research. 2014, h 5516–5517.
7. Arif M. Supply Chain Management. Yogyakarta: Deepublish; 2018, h 1, 6, 7, 11, 12.
8. Arora P. Material Management. India: Global India Publications; 2009, h vii.
9. Pandriadi, et al. Statistika Dasar. Bandung: Widina Media Utama; 2023, h 149.
10. Dahlan M. S. Statistik untuk Kedokteran dan Kesehatan. Jakarta: Salemba Medika; 2011, h 68.
11. Sofiyetti, et al. Bunga Rampai Statistik Kesehatan. Banyumas: Pena Persada Kerta Utama; 2023, h 109-111.
12. Corder G.W., Foreman D.I. Nonparametric Statistics for Non-Statisticians. New Jersey: John Wiley & Sons; 2009, h 44-45.
13. Woolson R.F., Clarke W.R. Statistical Methods for the Analysis of Biomedical Data: 2nd edition. New York: John Wiley & Sons; 2002, h 207.
14. Rowe P. Essential Statistics for the Pharmaceutical Sciences. England: John Wiley & Sons; 2007, h 144.